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Original Research Paper

Geospatial Modelling of Groundwater Fluctuation Using Remote Sensing and GIS - A Case Study for Hosur Union

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ABSTRACT

This paper describes the study of groundwater fluctuation in the study area using remote sensing and GIS technique. In this study, Hosur Union of Krishnagiri district, Tamil Nadu, was selected as the study area. The base map of the study area was prepared by using Survey of India Toposheet at a scale of 1:50000. The groundwater fluctuations were studied for varying rainfall intensity. The analysis was carried out using spatial interpolation technique and Thiessen polygon method. For the analysis by spatial interpolation technique, the water level fluctuations for every 4 years interval were considered. In this technique, spline method was used to create the continuous surface for groundwater data. This method considers the distance between both unknown points and known points and measures the spatial correlations between two points so that the weights can change according to the spatial arrangements of samples. In Thiessen polygon method, Voronoi polygons were created so that every location within a polygon is closer to the sample point in that polygon than any other sample point. The Voronoi mapping tool provides a number of methods for assigning or calculating values to polygons. The results by both the methods indicated that the overall groundwater potential is low in the study area.

INTRODUCTION

Groundwater is an important natural resource required for drinking, agriculture and industries etc. This resource can be optimally used and sustained only when the quantity and quality of groundwater is assessed properly. It is essential to maintain a proper balance between the available groundwater resource and its exploitation (Todd 1980). Otherwise it leads to large scale decline of groundwater levels, which ultimately causes serious problem in maintaining sustainable groundwater resources. A possible solution for such problem is micro level planning and use of standard methodology for accessing the groundwater (Ganesh Raj 1990). Geographical information system is one such a tool, which has the capability of modelling groundwater potential (Basappa Reddy 1985, Krishnamurthy et al. 1996). In this study, Hosur union of Krishnagiri district, Tamilnadu, is selected as study area for assessing the groundwater fluctuations. The Union is located about 45 km from of Bangalore city and lies between a latitude of 12°7’-12°44’ north and longitude of 77°30’-78°27’ east with a total area of 249 sq. km. The Hosur Union comprises 30 Panchayats consisting of 193 villages having a total population of 1,38,706 as per 2001 census. The topography of the study area has a minimum elevation 635 m above mean sea level and a maximum elevation of 1295 m above mean sea level. The maximum and minimum rainfall in the study area varied from 900 mm to 700 mm respectively. The geography of the study area is an undulating terrain with low altitude hills. The geological formations consist of hard rocks of granite and gneiss formation. The aquifer in this region is of unconfined nature.

Field data collection and analysis: In order to assess the groundwater level fluctuations in the study area, five observation wells and two rain gauge stations were selected. The rainfall data of rain gauge stations and data of groundwater level fluctuations were collected from Groundwater Board Division of District Collectorate and P.W.D. The field data collected is shown in Table 1. For the analysis the base map is prepared by using Survey of India Toposheet at a scale of 1:50000. The various features like boundaries, location of observation wells and rain gauge station are shown in Fig. 1. For the analysis by spatial interpolation technique, the water level fluctuations for every 4 years interval were considered. In this technique, spline method was used to create the continuous surface for groundwater data. This method considers the distance between both unknown points and known points and measures the spatial correlations between two points, so that the weights can change according to the spatial arrangement of samples (Gupta & Ganesh Raj 1992). The spatial distribution of groundwater for every four year interval is showed in Figs. 2 to 6.

Table 1: Groundwater level fluctuations in observations wells.

Year	Observation Wells Number				
	53029	53030	53045	53076	53077
1992	-1.94	-0.62	-1.77	-5.40	-4.00
1993	-0.02	0.16	-0.77	-0.43	-1.22
1994	-1.24	-1.05	-0.40	2.03	0.27
1995	-1.00	-1.95	-3.30	-1.10	-
1996	1.40	0.15	-0.05	1.35	-
1997	2.40	-0.95	5.53	1.65	4.40
1998	-0.75	0.90	-0.55	0.20	-1.55
1999	1.75	-0.5	-0.76	2.30	3.40
2000	-2.30	1.00	-1.32	-0.45	-0.8
2001	-3.95	0.05	0.30	1.30	0.40
2002	0.5	-0.65	-3.30	-	-
2003	3.50	5.25	-2.90	-	-
2004	2.40	1.00	1.25	-	-
2005	1.12	1.20	5.25	4.75	6.40
2006	-2.98	-2.35	-2.85	-4.20	-5.90
Net	-1.11	1.64	-5.64	12.80	1.82

In Thiessen polygon method, Voronoi polygons are created so that every location within a polygon is closer to the sample point in that polygon than any other sample point. After the polygons are created, neighbours of a sample point are defined as any other sample point whose polygon shares a border with the chosen sample point. The Voronoi mapping tool provides a number of methods for assigning or calculating values to polygons, i.e. simple mean, mode, standard deviation and cluster. Mean and mode are used for local smoothing; standard deviation is used for local variations. The Vornoi maps showing the variations in the groundwater levels are shown in Figs. 7 and 8.

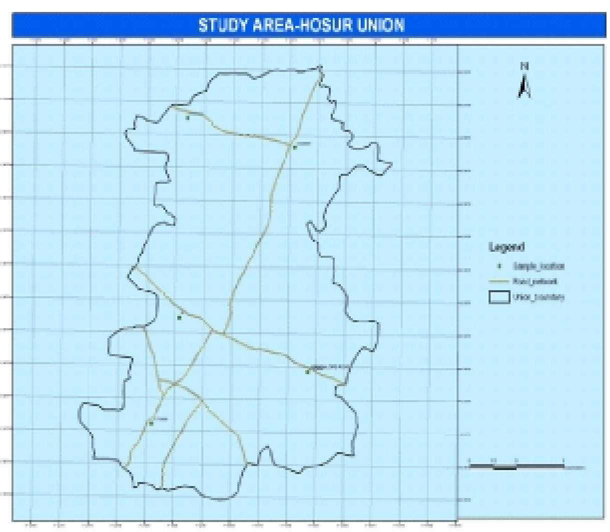

Fig.1: Locations of observation wells in the study area.

RESULTS AND DISCUSSION

Based on the observed field data the analyses were done by spatial interpolation technique. From the Figs. 2-6, it can be observed that during the year 1992, the southern part of the study area like Hosur town, Sipcot region has water level varying from 0.6 m to -0.4 m below the reference water table. Even though this region received a good

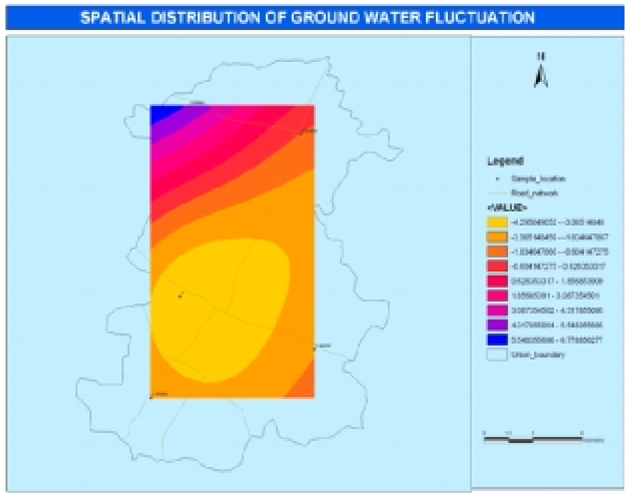

Fig. 2: Spatial distribution of groundwater fluctuation during the year (1992-1995).

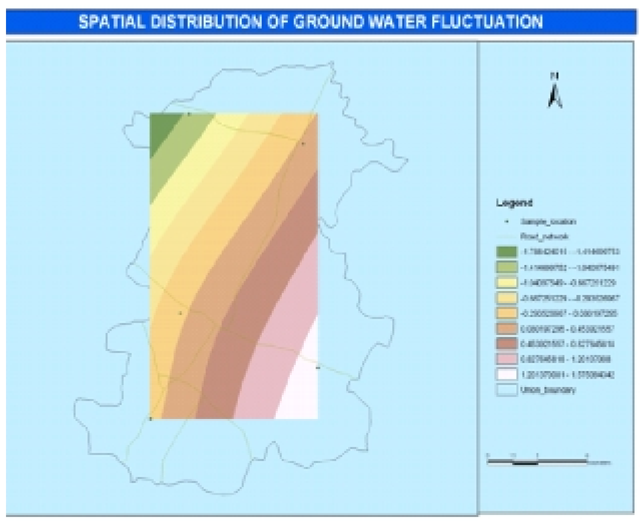

Fig.3: Spatial distribution of groundwater fluctuation during the year (1996-1999).

amount of rainfall of about 495mm in the same year, but it showed poor groundwater potential in the region. This is mainly due to overexploitation of groundwater in the region due to industrialization and urbanization. However, the northern part of the study area comprising of villages like Kaganur, Sevanapalli showed that the variation in the water wells were ranging from 3m to 7m above groundwater table. This indicates good amount of groundwater potential in the region. It was due to the fact that this region comes under agricultural zone where the pumping of water for other purposes was much lesser when compared to industrial and urban zones. In the year 1996-2000, overall study area showed the low water levels due to failure of monsoon. This region was also declared as a severe drought prone zone by Government of Tamil Nadu in the same period. In the year 2004, only a few regions showed a gradual increase in the groundwater level ranging from 1m to 2m above water

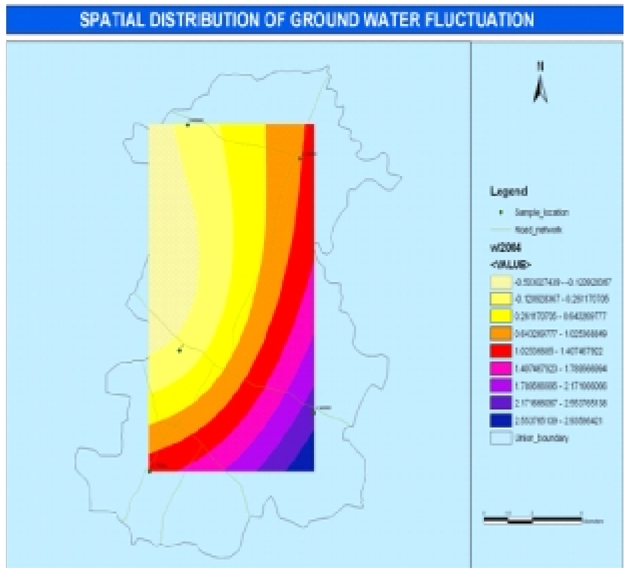

Fig.4: Spatial distribution of groundwater fluctuation during the year (2000-2003).

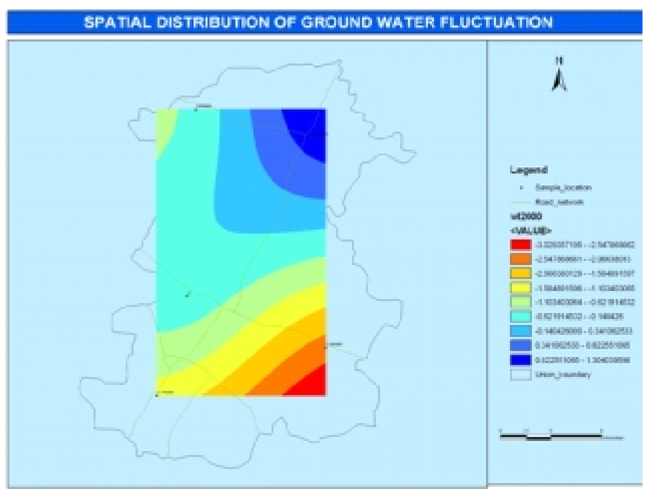

Fig.5: Spatial distribution of groundwater fluctuation during the year (2004-2005).

table. During the year 2006, the over all study area indicated the negative values ranging from -1m to -6m below water table even though this region has received highest rainfall of 1368 mm. This was mainly due to demographic increase in population, urbanization and industrialization in the region and natural recharge was very low in the region as it comprises of hard rock terrain and moderate permeability.

The results obtained from spatial interpolation technique were compared with Theissons polygon method. The results of this method also showed the water levels, as that was being predicted by continuous surface map. The Vornoi maps showing the variations in the groundwater levels are shown in Figs. 7 and 8.

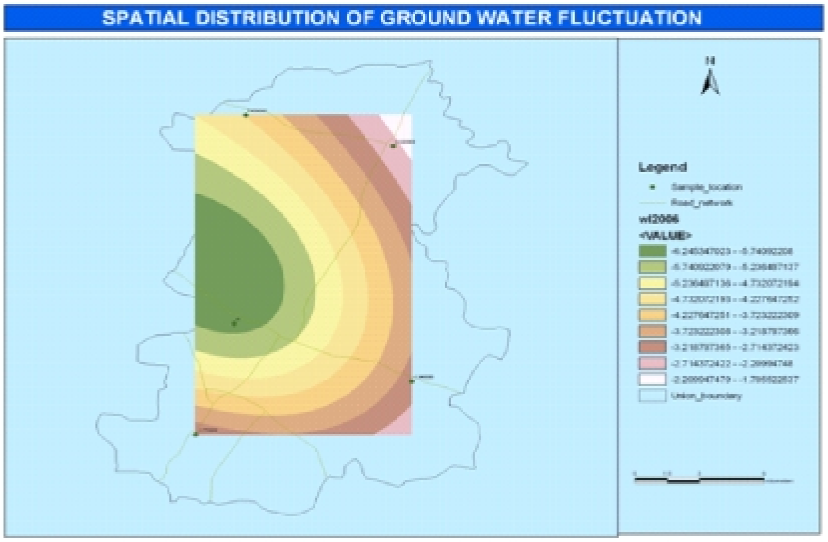

Fig.6: Spatial distribution of groundwater fluctuation during the year (2005-2006).

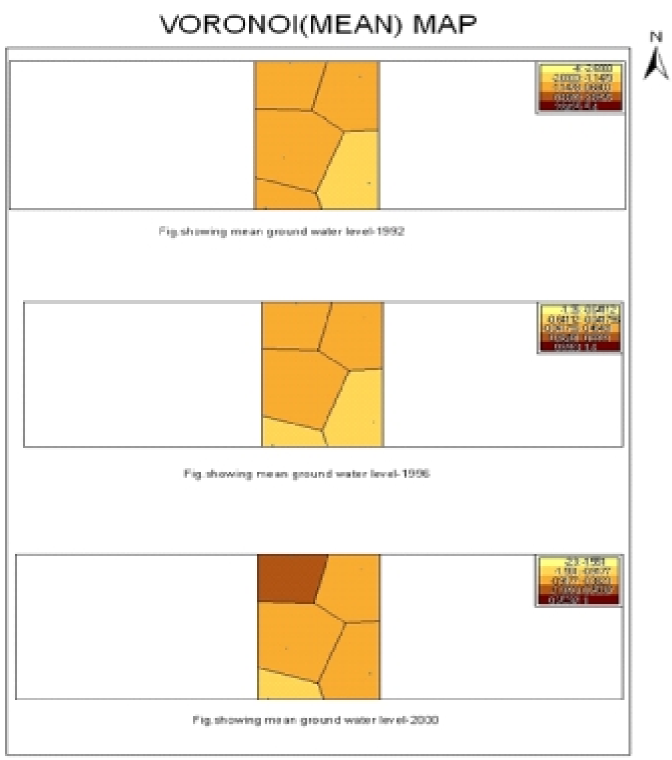

Fig. 7: Mean groundwater level during different years.

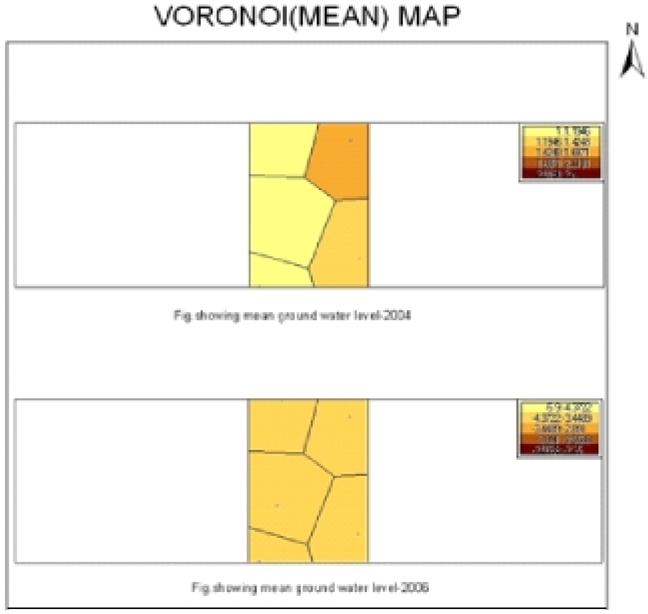

Fig. 8: Mean groundwater level during different years.

CONCLUSION

It can be concluded from the results that during the year 2006, groundwater level was below the water table level, even though the study area received the highest rainfall showing that the overall groundwater potential has reduced. The results of groundwater level fluctuations by spatial interpolation technique and Thessian polygon method reveal that overall groundwater potential is low in the study area. It is mainly due to increase in population, industrialization and urbanization. The geology and geomorphology of the study area show granitoid genesis and it is a hard rock terrain, where permeability is moderate and natural recharge is very low.

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